

Geologic Map of the Amboy Quadrangle, Clark and Cowlitz Counties, Washington By Russell C. Evarts

um- to coarse-grained, seriate to hypidiomorphic granular rock composed of plagioclase (about 60-65 percent; 1-2 mm across; partly replaced by stilbite and smectite), augite (about 15-20 percent; 0.5-1 mm across), Fe-Ti oxide (about 3 percent; 0.25 mm across), and interstitial quartz typically intergrown with fine-grained feldspar (about 15-

20 percent) and enclosing apatite needles Diorite of Buncombe Hollow (Miocene or Oligocene)—Large, multiphase, sill-like intrusion, nearly 150 m thick, of pyroxene diorite and microdiorite exposed on ridge between Lake Merwin and Buncombe Hollow Creek. Mostly dark- to medium-gray or greenish-gray, mediumto fine-grained, porphyritic to seriate rocks composed of plagioclase (50-60 percent; 1-3 mm long), augite (as much as 20 percent; 0.5 -1 mm across), hypersthene (0-6 percent; 0.5-1 mm across), olivine (0-3 percent; 0.5 -1 mm across; totally altered to smectite, serpentine, calcite), and Fe-Ti oxide (1-2 percent; 0.2-0.5 mm across) with minor interstitial quartz, smectite, and local traces of brown hornblende; some phases of intrusion coarser grained, with crystals of plagioclase as long as 8 mm and pyroxene as large as 3 mm across

Intrusive basalt (Eocene)—Dike of olivine-phyric basalt exposed in roadcut along State Route 503 directly west of Rock Creek; petrographically similar to and possibly feeder for nearby flow of olivine-phyric basalt (Tob)

Tiba Intrusive basaltic andesite (Eocene)—Several dikes of nearly aphyric basaltic andesite, as wide as 7 m, exposed in roadcut along State Route 503 west of mouth of Speelyai Creek, and a similar dike near mouth of Rock Creek. Contain sparse plagioclase phenocrysts and olivine and augite microphenocrysts in trachytic to pilotaxitic groundmass

Intrusive andesite (Eocene)—Dike of sparsely porphyritic andesite cutting volcaniclastic rocks along south shore of

Lake Merwin. Contains phenocrysts of plagioclase (1.9 percent; 0.5 to 1 mm long), augite (0.5 percent; 0.5 to 1 mm across), and hypersthene (0.2 percent; 0.5 mm long) and microphenocrysts of Fe-Ti oxide in a microphyric, pilotaxitic groundmass

Volcanic and sedimentary rocks

Basaltic andesite of Elkhorn Mountain (Oligocene)—Sequence of tholeiitic basaltic andesite and basalt flows and flow breccia in southern part of quadrangle; unit extends about 65 km south to Camas (R.C. Evarts, unpub. mapping). Flows are dark-gray to brown, porphyritic to seriate to aphyric, locally columnar-jointed, typically about 5-8 m thick. Typical porphyritic flows contain phenocrysts and glomerocrysts of weakly zoned plagioclase (0-45 percent; 1 to 6 mm, locally more than 10 mm long; variably replaced by zeolites and (or) clay) and olivine (<3 percent; 0.5 to 1 mm across; commonly partly resorbed and surrounded by rinds of granular pyroxene and (or) magnetite; invariably replaced by some combination of smectite, hematite, carbonate, serpentine, quartz and kaolinite). Some flows also contain phenocrysts of augite (<2 percent; 0.5 to 3 mm across) and microphenocrysts of Fe-Ti oxide; a few also contain phenocrysts of hypersthene, (<1 percent; 0.5 to 1 mm long). Groundmass consists of plagioclase, augite, Fe-Ti oxide, and minor to abundant interstitial glass (generally devitrified or replaced by smectite, quartz, or calcite); groundmass textures chiefly intergranular to trachytic, less commonly subophitic, intersertal, or microphyric. Many flows in unit abundantly plagioclase-phyric, as reflected in Al₂O₃ contents greater than 19 wt percent, and have probably accumulated excess feldspar. All flows in unit are tholeitic and relatively poor in Sr (mostly <320 ppm but higher in plagioclase-accumulative lavas) compared to mafic rocks elsewhere in southern Washington Cascade Range (Evarts, 2001, 2002, 2004a, b; R.C. Evarts, unpub. data). Base of unit is slight angular unconformity; whole-rock 40Ar/39Ar ages of approximately 27 Ma were obtained for unit in Yacolt quadrangle to

Andesite (Oligocene and Eocene)—Flows and flow breccia of medium- to dark-gray, variably vesicular, aphyric to porphyritic pyroxene andesite. Unit locally includes small flows of basaltic andesite and dacite and thin volcaniclastic interbeds. Typical andesite contains phenocrysts of plagioclase (1-35 percent; 1-5 mm long), augite (0-5 percent; <0.5 to 3 mm across), hypersthene (0-6 percent; <0.5 to 3 mm long), Fe-Ti oxide (≤0.5 percent; <0.5 mm across), and rare altered olivine (≤2 percent; as large as 2 mm across) in an intergranular, intersertal, pilotaxitic, hyalopilitic or cryptocrystalline groundmass; some sparsely porphyritic andesites lack augite or hypersthene or both. Alteration similar in mineralogy and intensity to that descri

bed for basaltic andesite (Tba) Tba Basaltic andesite (Oligocene and Eocene)—Flows and flow breccia of dark-gray to brown, porphyritic to seriate to aphyric basaltic andesite; unit locally includes minor andesite and basalt flows and volcaniclastic rocks too small or poorly exposed to map. Typical flows contain phenocrysts of plagioclase (0-45 percent; 1-2 mm, rarely to 5 mm long), olivine (as much as 7 percent; 0.5-2 mm across; commonly partly resorbed and surrounded by rinds of granular pyroxene and (or) magnetite; almost invariably replaced by some combination of smectite, hematite, carbonate, serpentine, and quartz; commonly contains minute inclusions of chromian spinel) and augite (as much as 5 percent; 0.5-3 mm across); some flows lack olivine and (or) augite phenocrysts; many contain microphenocrysts of Fe-Ti oxide and a few contain phenocrysts of hypersthene (as much as 2 percent; 0.5-1 mm long). Intergranular to trachytic groundmass consists of the same minerals plus minor interstitial glass (mostly altered to smectitic

clay, quartz, or calcite)

Volcaniclastic sedimentary rocks (Oligocene and Eocene)—Diverse assemblage of continental volcaniclastic rocks of inferred epiclastic origin. Consist of thin- to thick-bedded, well-sorted to poorly sorted siltstone, sandstone, conglomerate, and breccia, all composed of volcanic debris. Locally includes thin beds of pumiceous pyroclastic rocks and lava flows too small or poorly exposed to map. Beds most commonly light green to olive green or greenish-gray but also white, tan, or brown. Texturally and compositionally immature; most abundant clasts are volcanic rocks petrographically similar to interbedded lava flows and tuffs; other components include plagioclase, Fe-Ti oxide, and pyroxene crystals, pumice, vitric ash, fine-grained dioritic rocks, and plant remains. Interpreted as debris eroded from older and penecontemporaneous volcanoes and deposited by normal fluvial and lacustrine processes in low-lying medial to distal intervolcano environments. Typically display intense alteration to assemblages of clay minerals, zeolites (chiefly heulanditeclinoptilolite and laumontite), quartz, calcite, hematite, ce-

Tuff (Oligocene and Eocene)—Heterogeneous unit composed of light-green to brown andesitic to rhyolitic tuff, pumice-and lithic-lapilli tuff, and tuff breccia; very poorly sorted, matrix-supported, relatively coarse-grained deposits predominate; inferred to be mostly of pyroclastic-flow and lahar origin but doubtless includes some airfall tuff and reworked debris. As mapped, includes sequences of tuffaceous rocks interbedded with and gradational to subordinate pumice-poor epiclastic sedimentary rocks. Phenocrysts generally constitute less than 10 percent of juvenile material in tuff, and include plagioclase, augite, hyper-

sthene, and Fe-Ti oxide, but no quartz, amphibole or biotite. Alteration similar in character to that described for volcaniclastic sedimentary rocks (Tvs). Tuff in southern part of quadrangle generally more porphyritic, lithic-poor, and more densely welded than in most other areas; contains as much as 25 percent rounded and broken phenocrysts of plagioclase as well as minor brown hornblende. ⁴⁰Ar/³⁹Ar ages of 33.4±0.4 Ma and 33.0±0.1 Ma (table 2) were obtained from plagioclase in welded tuffs from southern part of quadrangle

Dacite (Oligocene and Eocene)—Scattered flows and flow breccia of variably porphyritic dacite; platy, typically flow-banded, and commonly vesicular; largely restricted to south half of quadrangle. Contain phenocrysts of plagioclase (5-20 percent; 1-3 mm long) and, in most samples, hypersthene (1-2 percent; 0.5-1 mm long), and augite (≤2 percent; 0.5-1 mm across), and microphenocrysts of Fe-Ti oxide (<0.5 percent) in a pilotaxitic, hyalopilitic, cryptocrystalline, or spherulitic groundmass. Commonly exhibits minor to pervasive low-temperature alteration, which imparts green, pink, purple, and brown colors; finegrained alteration assemblages include quartz, calcite, albite, clinoptilolite, hematite, montmorillonite, kaolinite, and titanite

Tuff of Davis Peak, outflow facies (Eocene)—Bed of porphyritic, densely welded, dacitic tuff exposed on south side of Cedar Creek at west edge of map area. As much as 30 m or more thick. Interpreted as outflow facies of pyroclastic deposits filling Davis Peak caldera in adjacent Ariel quadrangle, where an 40 Ar/39 Ar age of 35.1±0.3 Ma was obtained from this unit (Evarts, 2004b)

Olivine basalt (Eocene)—Dark-gray, porphyritic to seriate basalt with olivine as the sole or dominant phenocryst phase. Olivine phenocrysts (as much as 10 percent; 0.5-3.0 mm across) partly to completely replaced by smectite ± hematite; contain numerous tiny octahedral chromian spinel inclusions. Some samples also contain a few plagioclase phenocrysts. Intergranular to trachytic groundmass composed of plagioclase, augite, Fe-Ti oxide, and interstitial glass devitrified or altered to smectite; groundmass of one flow (table 1, no. 1) contains fine-grained phlogopite. Smectite and zeolite fill irregular microvesicles. Lenticular exposure, as thick as 150 m, on north slope of Green Mountain includes abundant brick-red scoriaceous againments.

Basalt (Eocene)—Isolated flows of aphyric to porphyritic plagioclase-phyric basalt in northern part of quadrangle. Porphyritic flows contain phenocrysts of plagioclase (as much as 20 percent; 1-3 mm long) and olivine (to 3 percent; 1-3 mm across; contains small inclusions of chromian spinel) in intergranular to trachytic groundmass of feldspar, augite, Fe-Ti oxide, minor olivine, and interstitial smectite

Plagioclase-phyric basalt (Eocene)—Flow of distinctive, dark-gray, coarsely and densely porphyritic basalt cropping out on steep valley walls of Speelyai Creek; as much as 30 m thick and more than 4 km long. Contains abundant large phenocrysts of plagioclase (15-45 percent; up to 10 mm long) and altered olivine (<0.5 percent; 1-2 mm across) in coarse-grained intergranular groundmass of feldspar, pyroxene, Fe-Ti oxide, minor altered olivine, and interstitial smectite

Contact—Dashed where approximately located; short-dashed where inferred; dotted where concealed

Fault—Dashed where inferred; dotted where concealed. Ball and bar on downthrown side. Arrows show relative horizontal movement. o, relative motion toward viewer; x, rel-

ative motion away from viewer

Strike and dip of beds

Strike and dip of compaction foliation in pumiceous lapilli

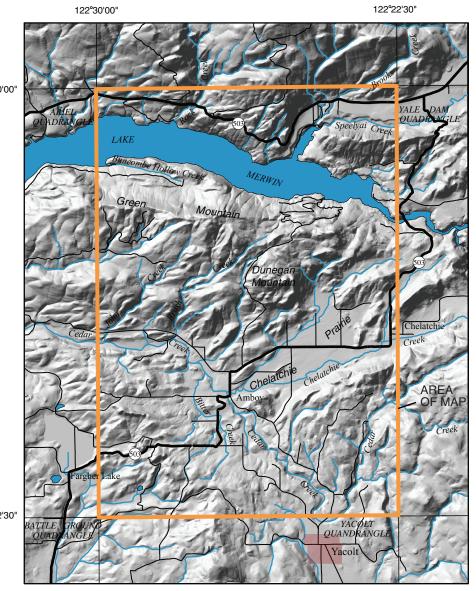
Strike and dip of platy parting in lava flows
 Sample locality for chemical analysis—See table 1

Sample locality for chemical analysis—See table 1

37.3±0.3

Sample locality for ⁴⁰Ar/³⁹Ar age determination and age in

Ma (±1-σ error)—See table 2 ⊗⊙ Relative motion of faults on cross section—x denotes motion away from viewer; dot denotes motion towards viewer



Index map showing geographic and cultural features mentioned in text (hillshade imagerived from 10-m DEM of the Amboy 7.5' quadrangle and vicinity)

Any use of trade, firm, or product names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1-888-ASK-USGS

Available on World Wide Web at http://pubs.usgs.gov/sim/2005/2855